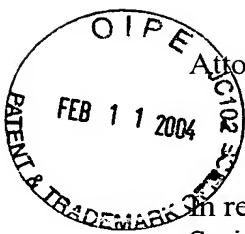


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PATENT

Attorney's Docket No. 5649-912



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Sang-bom Kang et al.

Serial No.: 10/050,195

Filed: January 16, 2002

For: INTEGRATED CIRCUIT DEVICE CONTACT PLUGS HAVING A LINER LAYER
THAT EXERTS COMPRESSIVE STRESS THEREON AND METHODS OF
MANUFACTURING SAME

Confirmation No.: 6301

Group Art Unit: 2811

Examiner: Junghwa M. Im

Date: February 9, 2004

Mail Stop Appeal Brief-Patents

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

**TRANSMITTAL OF APPEAL BRIEF
(PATENT APPLICATION--37 C.F.R. § 1.192)**

1. Transmitted herewith, in triplicate, is the APPEAL BRIEF for the above-identified application, pursuant to the Notice of Appeal filed on December 9, 2003.

2. This application is filed on behalf of
☐ a small entity.

3. Pursuant to 37 C.F.R. § 1.17(c), the fee for filing the Appeal Brief is:
☐ small entity \$165.00
☒ other than small entity \$330.00

Enclosed fee: \$330.00

4. ☒ A check in the amount of \$330.00 for the Appeal Brief is enclosed.

5. ☒ Any additional fee or refund may be charged to Deposit Account 50-0220.

Respectfully submitted,

D. Scott Moore

Registration No. 42,011

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Traci A. Brown

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. §1.192

Sir:

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences" filed December 9, 2003.

Real Party In Interest

The real party in interest is assignee Samsung Electronics Co., Ltd., 416
Maetan-dong, Paldal-gu, Suwon-City, Kyungki-do, Republic of Korea.

Related Appeals and Interferences

Appellants are aware of no appeals or interferences that would be affected by the present appeal.

Status of Claims

Appellants appeal the final rejection of Claims 1 - 14 and 25 - 32, which as of the filing date of this Brief remain under consideration. The claims at issue as amended in response to the Office Action of February 28, 2003 are attached hereto as Appendix A.

Status of Amendments

Two responses have been filed in the present case: A "Response To Restriction Requirement" was filed November 18, 2002 in response to an Office Action mailed October 23, 2002 (hereinafter "Restriction Requirement"). An "Amendment" was filed May 21, 2003 in response to an Office Action mailed February 28, 2003 (hereinafter "Office Action"). A final Office Action was mailed September 12, 2003 (hereinafter "Final Office Action") in response to the Amendment filed May 21, 2003. Claims 15 - 24 and 33 - 44 were canceled in the "Response To Restriction Requirement" filed November 18, 2002. Therefore, Claims 1 - 14 and 25 - 32 remain for consideration on the present appeal.

Summary of the Invention

Appellants' invention provides an integrated circuit device that comprises a substrate and an insulating layer that is disposed on the substrate and has a gap or hole formed therein. A liner layer that exhibits compressive stress characteristics is disposed on the sidewalls of the insulating layer, which define the gap, and also on the substrate in the gap. A contact plug that exhibits tensile stress characteristics is disposed directly on the liner layer. (Specification, page 4, lines 14 - 25).

In other embodiments, the liner layer and the contact plug comprise titanium nitride (TiN). (Specification, page 4, lines 21 - 25). The liner layer may be formed using one of the following methods: ionized physical vapor deposition (IPVD), metal organic chemical vapor deposition (MOCVD), metal organic atomic layer deposition (MOALD), sputtering, and collimator sputtering. (Specification, page 5, lines 5 - 17). The contact plug may be formed using one of the following methods: chemical vapor deposition (CVD), atomic layer deposition (ALD), MOCVD, and MOALD. (Specification, page 5, lines 3 - 5).

In further embodiments, an ohmic layer is disposed between the liner layer and the sidewalls of the insulating layer, and between the liner layer and the substrate. The ohmic layer may comprise titanium. (Specification, page 4, lines 23 - 25).

Issues

I. Is Claim 4 properly rejected under 35 U.S.C. §102(b) as being anticipated by U. S. Patent No. 5,672,543 to Chang *et al.* (hereinafter "Chang")?

II. Is Claim 25 properly rejected under 35 U.S.C. §103(a) as being as being unpatentable over Chang in view of U. S. Patent No. 6,404,058 to Taguwa (hereinafter "Taguwa") and further in view of U. S. Patent No. 6,534,809 to Moise (hereinafter "Moise")?

III. Is Claim 5 properly rejected under 35 U.S.C. §102(b) as being anticipated by Chang?

Grouping of Claims

For purposes of this appeal, Claims 4, 6, and 25 - 32 (Group I) may be considered as standing or falling together, and Claim 5 (Group II) may be considered as standing or falling together. Appellants respectfully submit that Claim 5 (Group II) is separately patentable from the Group I Claims because Claim 5 specifies a specific material for the ohmic layer, which provides separate grounds for patentability.

Argument

I. Introduction to 35 U.S.C. §102/103 Analysis

A claim is anticipated under 35 U.S.C. §102, if each claimed element is found in a single prior art reference. *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d 1565, 1576 (Fed. Cir. 1991); *Carella v. Starlight Archery and Pro Line Co.*, 804 F.2d 135, 138 (Fed. Cir. 1986). There must be no difference between the claimed invention and the reference disclosure, as viewed by an ordinary artisan. *Scripps Clinic & Research Foundation v. Genentech, Inc.*, 927 F.2d at 1576.

A determination under §103 that an invention would have been obvious to someone of ordinary skill in the art is a conclusion of law based on fact. *Panduit Corp. v. Dennison Mfg. Co.* 810 F.2d 1593, 1 U.S.P.Q.2d 1593 (Fed. Cir. 1987), *cert. denied*, 107 S.Ct. 2187. After the involved facts are determined, the decision maker must then make the legal determination of whether the claimed invention as a whole

would have been obvious to a person having ordinary skill in the art at the time the invention was unknown, and just before it was made. *Id.* at 1596. The United States Patent and Trademark Office (USPTO) has the initial burden under §103 to establish a *prima facie* case of obviousness. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988).

To establish a *prima facie* case of obviousness, the prior art reference or references when combined must teach or suggest *all* the recitations of the claims, and there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. M.P.E.P. §2143. The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. M.P.E.P. §2143.01, citing *In re Mills*, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir. 1990). As recently emphasized by the Court of Appeals for the Federal Circuit, to support combining references, evidence of a suggestion, teaching, or motivation to combine must be **clear and particular**, and this requirement for clear and particular evidence is not met by broad and conclusory statements about the teachings of references. *In re Dembiczak*, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999). In an even more recent decision, the Court of Appeals for the Federal Circuit has stated that, to support combining or modifying references, there must be **particular** evidence from the prior art as to the reason the skilled artisan, with no knowledge of the claimed invention, would have selected these components for combination in the manner claimed. *In re Kotzab*, 55 U.S.P.Q.2d 1313, 1317 (Fed. Cir. 2000).

Appellants respectfully submit that Claims 4 - 6 and 25 - 32 are patentable over the cited references for at least the reason that the cited references do not disclose or suggest the ohmic layer recited in Claims 4 and 25. The patentability of Claims 4 - 6 and 25 - 32 is discussed in detail hereinafter.

A. Claims 4 and 25 are Patentable

Dependent Claim 4 stands rejected under 35 U.S.C. §102(b) as being anticipated by Chang. Independent Claim 25 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Chang in view of Taguwa and further in view of Moise.

Dependent Claim 4 is directed to an integrated circuit device and includes the following recitation:

an ohmic layer disposed between the liner layer and the sidewalls of the insulating layer, and between the liner layer and the substrate.

Similarly, Claim 25 is directed to a contact plug of a semiconductor device and includes the following recitations:

a TiN plug having an upper surface contacting the upper conductive layer and having tensile stress;

a TiN liner contacting the TiN plug so as to surround the TiN plug along the side wall and the bottom of the TiN plug and having compressive stress; and

an ohmic layer contacting the TiN liner on the opposite side of the TiN plug and located between the TiN liner and the insulating film and between the TiN liner and the lower conductive layer.

Thus, both Claims 4 and 25 recite that an ohmic layer is disposed between the liner layer and the insulating layer/film and between the liner layer and the substrate or lower conductive layer. The ohmic layer is illustrated, for example, in the Specification as layer 14 in FIG. 1 and layer 120 in FIG. 3E.

The Final Office Action states that Chang shows a semiconductor device in FIG. 1 in which an ohmic layer 24 is disposed between a liner and an insulating layer. (Final Office Action, pages 2 and 4). In sharp contrast with the recitations of Claims 4 and 25, however, the layer 24 shown, for example, in FIG. 1 of Chang, is not an ohmic layer, but is instead a titanium glue layer used to enhance the adherence of the titanium nitride barrier layer 26. (Chang, col. 1, lines 16 - 18). Appellants respectfully submit that a titanium glue layer is not an ohmic layer as it does not reduce the resistance difference between titanium nitride barrier layer 26 and the source/drain region 14, for example. Appellants further submit that none of the other cited references provide the teachings missing from Chang.

Accordingly, for at least the foregoing reasons, Appellants respectfully submit that dependent Claim 4 and independent Claim 25 are patentable over the cited references and that dependent Claims 5, 6 and 26 - 32 are patentable at least per the patentability of Claims 4 and 25. Accordingly, Appellants respectfully request that

the rejection of Claims 4 - 6 and 25 - 32 (Groups I and II) be reversed based on the failure of the Examiner to establish a prima facie case of anticipation under 35 U.S.C. §102 and obviousness under 35 U.S.C. §103 for at least these reasons.

B. Claim 5 is Patentable

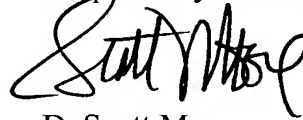
Dependent Claim 5 stands rejected under 35 U.S.C. §102(b) as being anticipated by Chang. (Final Office Action, page 2). With regard to Claim 5, this claim includes all of the recitations from dependent Claim 4 and is, therefore, patentable over Chang for at least the reasons stated above. In addition, Appellants respectfully submit that the Chang does not disclose or suggest that the ohmic layer comprises titanium. Instead, layer 24 shown in FIG. 1 of Chang, which is alleged to correspond to the ohmic layer recited in Claim 5 as discussed above, is a titanium glue layer. (Chang, col. 1, lines 16 - 18). That is, it is a glue for another layer 26 that comprises titanium. Therefore, Appellants submit that, in addition to the foregoing reasons, Claim 5 is separately patentable for at least these additional reasons. Accordingly, Appellants respectfully request that the rejection of Claim 5 (Group II) be reversed based on the failure of the Examiner to establish a prima facie case of anticipation under 35 U.S.C. §102 for at least these additional reasons.

In re: Sang-bom Kang et al.
Serial No.: 10/050,195
Filed: January 16, 2002
Page 7

II. Conclusion

In summary, Appellants respectfully submit that, with respect to Claims 4 - 6 and 25 - 32 (Groups I and II) the cited references do not teach all of the recitations of the claims. Accordingly, Appellants respectfully request reversal of the rejection of Claims 4 - 6 and 25 - 32 (Groups I and II) based on the cited references.

Respectfully submitted,



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Traci A. Brown

APPENDIX A

1. An integrated circuit device, comprising:
a substrate;
an insulating layer disposed on the substrate having a gap formed therein;
a liner layer that exhibits compressive stress characteristics disposed on sidewalls of the insulating layer, which define the gap, and on the substrate in the gap;
and
a contact plug that exhibits tensile stress characteristics disposed directly on the liner layer.
2. The integrated circuit device of Claim 1, wherein the liner layer and the contact plug comprise titanium nitride (TiN).
3. The integrated circuit device of Claim 1, wherein the liner layer has an amorphous structure.
4. The integrated circuit device of Claim 1, further comprising:
an ohmic layer disposed between the liner layer and the sidewalls of the insulating layer, and between the liner layer and the substrate.
5. The integrated circuit device of Claim 4, wherein the ohmic layer comprise titanium (Ti).
6. The integrated circuit device of Claim 4, wherein the ohmic layer has a thickness of about 70 Å - 100 Å.
7. The integrated circuit device of Claim 1, wherein the liner layer has a thickness of about 200 Å - 500 Å.
8. The integrated circuit device of Claim 1, further comprising:

a wiring layer disposed on an upper surface of the contact plug opposite the substrate.

9. The integrated circuit device of Claim 1, wherein the wiring layer comprises a metal material.

10. The integrated circuit device of Claim 1, wherein the wiring layer comprises at least one of tungsten (W) and aluminum (Al).

11. The integrated circuit device of Claim 1, further comprising:
a capacitor disposed on an upper surface of the contact plug opposite the substrate.

12. The integrated circuit device of Claim 11, wherein the capacitor comprises a lower electrode that contacts the upper surface of the contact plug.

13. The integrated circuit device of Claim 12, wherein the lower electrode comprises at least one of the following materials: W, Pt, Ru, Ir, TiN, TaN, WN, RuO₂, and IrO₂.

14. The integrated circuit device of Claim 1, wherein the gap is wider at a surface of the insulating layer opposite the substrate than the gap is at another location.

25. A contact plug of a semiconductor device formed through an insulating film interposed between a lower conductive layer and an upper conductive layer to electrically connect the lower conductive layer to the upper conductive layer, comprising:

a TiN plug having an upper surface contacting the upper conductive layer and having tensile stress;

a TiN liner contacting the TiN plug so as to surround the TiN plug along the side wall and the bottom of the TiN plug and having compressive stress; and

an ohmic layer contacting the TiN liner on the opposite side of the TiN plug and located between the TiN liner and the insulating film and between the TiN liner and the lower conductive layer.

26. The contact plug of Claim 25, wherein the TiN plug comprises a TiN film formed by chemical vapor deposition (CVD), atomic layer deposition (ALD), metal organic CVD (MOCVD), or metal organic ALD (MOALD).

27. The contact plug of Claim 25, wherein the TiN liner comprises a TiN film formed by ionized physical vapor deposition (IPVD), metal organic CVD (MOCVD), metal organic ALD (MOALD), sputtering, or collimator sputtering.

28. The contact plug of Claim 25, wherein the TiN liner has an amorphous structure.

29. The contact plug of Claim 28, wherein the TiN liner comprises a TiN film formed by ionized physical vapor deposition (IPVD).

30. The contact plug of Claim 25, wherein the TiN plug has a bottom surface, which contacts the TiN liner, and the upper surface of the TiN plug has a width greater than the width of the bottom surface.

31. The contact plug of Claim 25, wherein the upper conductive layer comprises at least one film selected from the group of films consisting of W, Al, Pt, Ru, Ir, TiN, TaN, WN, RuO₂, and IrO₂.

32. The contact plug of Claim 25, wherein the upper conductive layer comprises a lower electrode of a capacitor.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Sang-bom Kang et al.	Confirmation No.: 6301
Serial No.: 10/050,195	Group Art Unit: 2811
Filed: January 16, 2002	Examiner: Junghwa M. Im
For: INTEGRATED CIRCUIT DEVICE CONTACT PLUGS HAVING A LINER LAYER THAT EXERTS COMPRESSIVE STRESS THEREON AND METHODS OF MANUFACTURING SAME	

Date: February 9, 2004

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. §1.192

Sir:

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences" filed December 9, 2003.

Real Party In Interest

The real party in interest is assignee Samsung Electronics Co., Ltd., 416 Maetan-dong, Paldal-gu, Suwon-City, Kyungki-do, Republic of Korea.

Related Appeals and Interferences

Appellants are aware of no appeals or interferences that would be affected by the present appeal.

Status of Claims

Appellants appeal the final rejection of Claims 1 - 14 and 25 - 32, which as of the filing date of this Brief remain under consideration. The claims at issue as amended in response to the Office Action of February 28, 2003 are attached hereto as Appendix A.

Status of Amendments

Two responses have been filed in the present case: A "Response To Restriction Requirement" was filed November 18, 2002 in response to an Office Action mailed October 23, 2002 (hereinafter "Restriction Requirement"). An "Amendment" was filed May 21, 2003 in response to an Office Action mailed February 28, 2003 (hereinafter "Office Action"). A final Office Action was mailed September 12, 2003 (hereinafter "Final Office Action") in response to the Amendment filed May 21, 2003. Claims 15 - 24 and 33 - 44 were canceled in the "Response To Restriction Requirement" filed November 18, 2002. Therefore, Claims 1 - 14 and 25 - 32 remain for consideration on the present appeal.

Summary of the Invention

Appellants' invention provides an integrated circuit device that comprises a substrate and an insulating layer that is disposed on the substrate and has a gap or hole formed therein. A liner layer that exhibits compressive stress characteristics is disposed on the sidewalls of the insulating layer, which define the gap, and also on the substrate in the gap. A contact plug that exhibits tensile stress characteristics is disposed directly on the liner layer. (Specification, page 4, lines 14 - 25).

In other embodiments, the liner layer and the contact plug comprise titanium nitride (TiN). (Specification, page 4, lines 21 - 25). The liner layer may be formed using one of the following methods: ionized physical vapor deposition (IPVD), metal organic chemical vapor deposition (MOCVD), metal organic atomic layer deposition (MOALD), sputtering, and collimator sputtering. (Specification, page 5, lines 5 - 17). The contact plug may be formed using one of the following methods: chemical vapor deposition (CVD), atomic layer deposition (ALD), MOCVD, and MOALD. (Specification, page 5, lines 3 - 5).

In further embodiments, an ohmic layer is disposed between the liner layer and the sidewalls of the insulating layer, and between the liner layer and the substrate. The ohmic layer may comprise titanium. (Specification, page 4, lines 23 - 25).

Issues

I. Is Claim 4 properly rejected under 35 U.S.C. §102(b) as being anticipated by U. S. Patent No. 5,672,543 to Chang *et al.* (hereinafter "Chang")?

II. Is Claim 25 properly rejected under 35 U.S.C. §103(a) as being as being unpatentable over Chang in view of U. S. Patent No. 6,404,058 to Taguwa (hereinafter "Taguwa") and further in view of U. S. Patent No. 6,534,809 to Moise (hereinafter "Moise")?

III. Is Claim 5 properly rejected under 35 U.S.C. §102(b) as being anticipated by Chang?

Grouping of Claims

For purposes of this appeal, Claims 4, 6, and 25 - 32 (Group I) may be considered as standing or falling together, and Claim 5 (Group II) may be considered as standing or falling together. Appellants respectfully submit that Claim 5 (Group II) is separately patentable from the Group I Claims because Claim 5 specifies a specific material for the ohmic layer, which provides separate grounds for patentability.

Argument

I. Introduction to 35 U.S.C. §102/103 Analysis

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would have been obvious to a person having ordinary skill in the art at the time the invention was unknown, and just before it was made. *Id.* at 1596. The United States Patent and Trademark Office (USPTO) has the initial burden under §103 to establish a *prima facie* case of obviousness. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1598 (Fed. Cir. 1988).

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Appellants respectfully submit that Claims 4 - 6 and 25 - 32 are patentable over the cited references for at least the reason that the cited references do not disclose or suggest the ohmic layer recited in Claims 4 and 25. The patentability of Claims 4 - 6 and 25 - 32 is discussed in detail hereinafter.

A. Claims 4 and 25 are Patentable

Dependent Claim 4 stands rejected under 35 U.S.C. §102(b) as being anticipated by Chang. Independent Claim 25 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Chang in view of Taguwa and further in view of Moise.

Dependent Claim 4 is directed to an integrated circuit device and includes the following recitation:

an ohmic layer disposed between the liner layer and the sidewalls of the insulating layer, and between the liner layer and the substrate.

Similarly, Claim 25 is directed to a contact plug of a semiconductor device and includes the following recitations:

a TiN plug having an upper surface contacting the upper conductive layer and having tensile stress;

a TiN liner contacting the TiN plug so as to surround the TiN plug along the side wall and the bottom of the TiN plug and having compressive stress; and

an ohmic layer contacting the TiN liner on the opposite side of the TiN plug and located between the TiN liner and the insulating film and between the TiN liner and the lower conductive layer.

Thus, both Claims 4 and 25 recite that an ohmic layer is disposed between the liner layer and the insulating layer/film and between the liner layer and the substrate or lower conductive layer. The ohmic layer is illustrated, for example, in the Specification as layer 14 in FIG. 1 and layer 120 in FIG. 3E.

The Final Office Action states that Chang shows a semiconductor device in FIG. 1 in which an ohmic layer 24 is disposed between a liner and an insulating layer. (Final Office Action, pages 2 and 4). In sharp contrast with the recitations of Claims 4 and 25, however, the layer 24 shown, for example, in FIG. 1 of Chang, is not an ohmic layer, but is instead a titanium glue layer used to enhance the adherence of the titanium nitride barrier layer 26. (Chang, col. 1, lines 16 - 18). Appellants respectfully submit that a titanium glue layer is not an ohmic layer as it does not reduce the resistance difference between titanium nitride barrier layer 26 and the source/drain region 14, for example. Appellants further submit that none of the other cited references provide the teachings missing from Chang.

Accordingly, for at least the foregoing reasons, Appellants respectfully submit that dependent Claim 4 and independent Claim 25 are patentable over the cited references and that dependent Claims 5, 6 and 26 - 32 are patentable at least per the patentability of Claims 4 and 25. Accordingly, Appellants respectfully request that

the rejection of Claims 4 - 6 and 25 - 32 (Groups I and II) be reversed based on the failure of the Examiner to establish a prima facie case of anticipation under 35 U.S.C. §102 and obviousness under 35 U.S.C. §103 for at least these reasons.

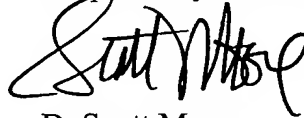
B. Claim 5 is Patentable

Dependent Claim 5 stands rejected under 35 U.S.C. §102(b) as being anticipated by Chang. (Final Office Action, page 2). With regard to Claim 5, this claim includes all of the recitations from dependent Claim 4 and is, therefore, patentable over Chang for at least the reasons stated above. In addition, Appellants respectfully submit that the Chang does not disclose or suggest that the ohmic layer comprises titanium. Instead, layer 24 shown in FIG. 1 of Chang, which is alleged to correspond to the ohmic layer recited in Claim 5 as discussed above, is a titanium glue layer. (Chang, col. 1, lines 16 - 18). That is, it is a glue for another layer 26 that comprises titanium. Therefore, Appellants submit that, in addition to the foregoing reasons, Claim 5 is separately patentable for at least these additional reasons. Accordingly, Appellants respectfully request that the rejection of Claim 5 (Group II) be reversed based on the failure of the Examiner to establish a prima facie case of anticipation under 35 U.S.C. §102 for at least these additional reasons.

II. Conclusion

In summary, Appellants respectfully submit that, with respect to Claims 4 - 6 and 25 - 32 (Groups I and II) the cited references do not teach all of the recitations of the claims. Accordingly, Appellants respectfully request reversal of the rejection of Claims 4 - 6 and 25 - 32 (Groups I and II) based on the cited references.

Respectfully submitted,

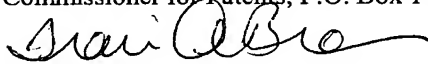


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Traci A. Brown

APPENDIX A

1. An integrated circuit device, comprising:
a substrate;
an insulating layer disposed on the substrate having a gap formed therein;
a liner layer that exhibits compressive stress characteristics disposed on sidewalls of the insulating layer, which define the gap, and on the substrate in the gap;
and
a contact plug that exhibits tensile stress characteristics disposed directly on the liner layer.
2. The integrated circuit device of Claim 1, wherein the liner layer and the contact plug comprise titanium nitride (TiN).
3. The integrated circuit device of Claim 1, wherein the liner layer has an amorphous structure.
4. The integrated circuit device of Claim 1, further comprising:
an ohmic layer disposed between the liner layer and the sidewalls of the insulating layer, and between the liner layer and the substrate.
5. The integrated circuit device of Claim 4, wherein the ohmic layer comprise titanium (Ti).
6. The integrated circuit device of Claim 4, wherein the ohmic layer has a thickness of about 70 Å - 100 Å.
7. The integrated circuit device of Claim 1, wherein the liner layer has a thickness of about 200 Å - 500 Å.
8. The integrated circuit device of Claim 1, further comprising:

a wiring layer disposed on an upper surface of the contact plug opposite the substrate.

9. The integrated circuit device of Claim 1, wherein the wiring layer comprises a metal material.

10. The integrated circuit device of Claim 1, wherein the wiring layer comprises at least one of tungsten (W) and aluminum (Al).

11. The integrated circuit device of Claim 1, further comprising:
a capacitor disposed on an upper surface of the contact plug opposite the substrate.

12. The integrated circuit device of Claim 11, wherein the capacitor comprises a lower electrode that contacts the upper surface of the contact plug.

13. The integrated circuit device of Claim 12, wherein the lower electrode comprises at least one of the following materials: W, Pt, Ru, Ir, TiN, TaN, WN, RuO₂, and IrO₂.

14. The integrated circuit device of Claim 1, wherein the gap is wider at a surface of the insulating layer opposite the substrate than the gap is at another location.

25. A contact plug of a semiconductor device formed through an insulating film interposed between a lower conductive layer and an upper conductive layer to electrically connect the lower conductive layer to the upper conductive layer, comprising:

a TiN plug having an upper surface contacting the upper conductive layer and having tensile stress;

a TiN liner contacting the TiN plug so as to surround the TiN plug along the side wall and the bottom of the TiN plug and having compressive stress; and

an ohmic layer contacting the TiN liner on the opposite side of the TiN plug and located between the TiN liner and the insulating film and between the TiN liner and the lower conductive layer.

26. The contact plug of Claim 25, wherein the TiN plug comprises a TiN film formed by chemical vapor deposition (CVD), atomic layer deposition (ALD), metal organic CVD (MOCVD), or metal organic ALD (MOALD).

27. The contact plug of Claim 25, wherein the TiN liner comprises a TiN film formed by ionized physical vapor deposition (IPVD), metal organic CVD (MOCVD), metal organic ALD (MOALD), sputtering, or collimator sputtering.

28. The contact plug of Claim 25, wherein the TiN liner has an amorphous structure.

29. The contact plug of Claim 28, wherein the TiN liner comprises a TiN film formed by ionized physical vapor deposition (IPVD).

30. The contact plug of Claim 25, wherein the TiN plug has a bottom surface, which contacts the TiN liner, and the upper surface of the TiN plug has a width greater than the width of the bottom surface.

31. The contact plug of Claim 25, wherein the upper conductive layer comprises at least one film selected from the group of films consisting of W, Al, Pt, Ru, Ir, TiN, TaN, WN, RuO₂, and IrO₂.

32. The contact plug of Claim 25, wherein the upper conductive layer comprises a lower electrode of a capacitor.